

CLOSURE PLUG FOR OPEN-HEADED MEDICAL IMPLANT

Cross Reference to Related Applications

The present application is a division of U.S. Serial No. 10/014,434 filed November 9, 2001 of the same name, now Patent No. __, __, __, which was a continuation-in-part of U.S. Serial No. 09/732,528 that was filed December 7, 2000, now Patent No. __, __, __.

Background of the Invention

1 The present invention is directed to an open headed
2 medical implant and, in particular, to a closure for closing
3 the head of an open headed bone screw, hook or the like.

4 Bone screws are used especially in spinal surgery to
5 support and position various implants needed to repair a
6 spine that has suffered injury, illness or genetic defect.
7 Bone screws of this type are screwed into the vertebrae of
8 the spine and have a head that projects outside the bone
9 which receives other implants, such as rods, that extend
10 along the spine. Bone screws are of two general types which
11 are either open headed or closed headed. Hooks and certain
12 other implants also sometimes have open heads. The present

1 application is directed to open headed bone screws and
2 related implants such as hooks and the like that have such
3 an open head to receive another implant.

4 In open headed bone screws and related implants, the
5 head includes two upright arms that form a channel
6 therebetween. The channel is sized to receive a rod or the
7 like and is open to make it easier to place the rod in the
8 head. The rod must then be tightly held or locked in the
9 head to prevent relative movement between implants after the
10 surgery. To hold the rod in the head, plugs have been used
11 that are screwed into threads on the interior surfaces of
12 the arms.

13 The present invention is directed especially to
14 improvements in such plugs or closures that make them easier
15 to insert in the head, that better ensure that the plug
16 effectively secures the rod so that the rod does not later
17 slip, that allow the plugs to be easily removed should the
18 overall implant system require rearrangement and which
19 provide a comparatively low profile, so as reduce trauma and
20 irritation to the surrounding tissues of the patient.

21
22 Summary of the Invention
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1 A closure is provided for an open headed implant,
2 especially a bone screw or hook for use in spinal surgery.
3 The closure has a cylindrical shaped body with an axis of
4 rotation. The body has a radially outer surface that is
5 threaded with a thread that is sized and shaped to be
6 received in mating threads on interior surfaces of arms of
7 the implant head. The closure is operably threaded into the
8 head of the implant to capture a rod or other part of an
9 overall spinal support system. The closure captures and
10 locks such a rod in position relative to the implant to
11 prevent rotation or axial movement between the joined parts.

12 The closure body has a top surface and a bottom surface
13 with a plurality of bores extending parallel to the axis of
14 rotation into the body from the top surface. The bores are
15 positioned in spaced relationship to one another and to the
16 axis of rotation. The bores are sized and shaped to
17 cooperatively mate with posts on a tool to allow removal of
18 the closure from the implant after insertion, should such be
19 necessary. In some instances the tool may also be used to
20 install the closure in the implant.

21 In one embodiment the closure also includes a break-off
22 head centrally mounted by a neck on the top surface of the
23 body. The break-off head is adapted to receive a socket

1 tool and be rotated thereby during installation. The break-
2 off head is also designed to break from the body at a break-
3 off point or location which is preferably whereat the neck
4 intersects with the top surface of the body; when a
5 preselected torque is applied to the break-off head. When
6 the break-off head is broken away, the bores that are
7 adapted to mate with a removal tool become exposed.

8 In a second embodiment the body includes a central
9 threaded bore that receives a set screw. The body is then
10 used for capture of a rod or the like and the set screw is
11 used to lock the rod or the like in position relative to the
12 implant.

13 In a third embodiment, a body includes both a break-off
14 head and a central threaded bore that is covered by the
15 break-off head until the head breaks away, after which the
16 threaded bore is exposed at the top surface of the body to
17 receive a set screw.

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19 Objects and Advantages of the Invention

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21 Therefore, the objects of the present invention are: to
22 provide a closure for an open ended implant that provides a
23 plurality of spaced bores that are offset from an axis of

1 rotation of the closure and that cooperate with a tool to
2 allow removal of the closure; to provide such an implant
3 having a closure with a break off head for mating with an
4 insertion tool for inserting the closure into the implant;
5 to provide such an implant wherein the removal bores are not
6 accessible for effective access, when the closure is in the
7 implant until the break-off head is broken away; to provide
8 such an implant having a closure wherein a closure body has
9 an axially centered threaded bore and including a set screw
10 sized and shaped to be threaded into and extend from the
11 bottom of the closure threaded bore when fully inserted
12 therein; to provide such an implant having a break-off head
13 joined by a neck to a body of the closure and centered on a
14 top of the closure with the body also having a central
15 threaded bore that extends from a bottom to the top of the
16 closure body, but the threaded bore is inaccessible at the
17 top of the body until the break-off head breaks from the
18 body; to provide such an implant that strongly grips a rod
19 or the like received in the implant and that provides a
20 relatively low profile; and to provide such an implant and
21 closure therefore that is relatively easy to use,
22 comparatively easy to produce and is especially well suited
23 for the intended use thereof.

1 Other objects and advantages of this invention will
2 become apparent from the following description taken in
3 conjunction with the accompanying drawings wherein are set
4 forth, by way of illustration and example, certain
5 embodiments of this invention.

6 The drawings constitute a part of this specification
7 and include exemplary embodiments of the present invention
8 and illustrate various objects and features thereof.

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10 Brief Description of the Drawings

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12 Fig. 1 is an exploded perspective view of a bone screw
13 type implant and closure cap in accordance with the present
14 invention prior to insertion of the closure cap into a head
15 of the bone screw.

16 Fig. 2 is a fragmentary side elevational view of the
17 bone screw with a rod and the closure received therein and
18 with a tool being utilized to insert the closure and provide
19 torque to the break-off head of the closure and further with
20 the bone screw shown embedded in a bone that is indicated by
21 phantom lines.

22 Fig. 3 is a fragmentary and exploded side elevational
23 view of the bone screw, rod and closure with the break-off

1 head of the closure being shown broken therefrom.

2 Fig. 4 is a fragmentary top plan view of the bone
3 screw, rod and closure with the break-off head removed.

4 Fig. 5 is a top plan view of the closure with the
5 break-off head broken therefrom, but shown in phantom.

6 Fig. 6 is a bottom plan view of the closure.

7 Fig. 7 is an exploded and fragmentary side elevational
8 view of the bone screw, rod and closure showing a removal
9 tool positioned above the closure.

10 Fig. 8 is a fragmentary and enlarged view of the bone
11 screw, rod and closure shown in Fig. 7 with the removal tool
12 inserted into the closure and with portions of the bone
13 screw and closure broken away to show detail thereof.

14 Fig. 9 is an exploded perspective view of a modified
15 bone screw and closure in accordance with the present
16 invention, also showing a rod received in a head of the bone
17 screw in phantom lines and a tool for use in inserting the
18 closure into and removing the closure from the head of the
19 bone screw.

20 Fig. 10 is a side elevational view of the bone screw,
21 rod, closure and tool of the second embodiment of the
22 invention with portions broken away to show internal detail
23 thereof.

1 Fig. 11 is a fragmentary side elevational view of the
2 bone screw, rod and closure also showing a set screw that is
3 positioned to be received in the closure.

4 Fig. 12 is a fragmentary side elevational view showing
5 the bone screw, rod, closure and closure set screw
6 positioned in a vertebrae that is shown in cross-section.

7 Fig. 13 is a front elevational view of the bone screw,
8 rod and closure shown mounted in a vertebrae that is shown
9 in cross-section.

10 Fig. 14 is a side elevational view of a closure in
11 accordance with a second modified embodiment of the present
12 invention.

13 Fig. 15 is a top plan view of the closure of the second
14 modified embodiment with a break-off head thereof broken
15 away.

16 Fig. 16 is a bottom plan view of the closure of the
17 second modified embodiment of the invention.

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19 Detailed Description of the Invention

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21 As required, detailed embodiments of the present
22 invention are disclosed herein; however, it is to be
23 understood that the disclosed embodiments are merely

1 exemplary of the invention, which may be embodied in various
2 forms. Therefore, specific structural and functional
3 details disclosed herein are not to be interpreted as
4 limiting, but merely as a basis for the claims and as a
5 representative basis for teaching one skilled in the art to
6 variously employ the present invention in virtually any
7 appropriately detailed structure.

8 The reference numeral 1 generally indicates a first
9 embodiment of a medical implant in accordance with the
10 present invention which is shown in Figures 1 to 8. The
11 implant 1 includes a bone screw 5, a closure 6 for the bone
12 screw and a rod 7. The implant is received in a vertebrae
13 9, typically in conjunction with other implants that are not
14 shown. The closure 6 also functions in conjunction with
15 other open-headed implants, such as hooks and the like.

16 The bone screw 5 includes a shank 12 and a head 13.
17 The shank 12 is threaded with a coarse flanging-like thread
18 16 that is threaded into the vertebrae 9 so as to secure and
19 support the bone screw 5 and allow the head 13 to extend
20 from the vertebrae 9.

21 The bone screw head 13 includes a base 20 with a pair
22 of upstanding spaced arms 21 and 22 on opposite sides of the
23 base 20 forming a generally U-shaped configuration when

1 viewed from the side and defining a channel 23 therebetween.

2 The channel 23 is sized and shaped to receive the rod 7.

3 The arms 21 and 22 each include an interior threaded
4 surface 26 and 27 respectively. The threaded surfaces 26
5 and 27 are spaced and not connected so as to present only a
6 partial threadform which each face one another and cooperate
7 with the closure 6, as is noted below. In the illustrated
8 embodiment, the threaded surfaces 26 and 27 extend from a
9 top 30 of the bone screw only partially down the arms 21 and
10 22.

11 The closure 6 includes a body 35 and a break-off head
12 36. In the present embodiment shown in Figs. 1 through 8
13 the closure body 35 is generally cylindrical in shape and
14 has a radially outward external threaded surface 40 that
15 extends 360° about an axis of rotation indicated by the
16 reference letter "A". That is, the threaded surface has a
17 threadform located thereon that entirely encircles the outer
18 threaded surface 40 of the body 35 and extends entirely from
19 top to bottom. The threaded surface 40 is provided with a
20 thread that is sized, shaped and configured to rotatably
21 mate with the threaded surfaces 26 and 27 of the arms 21 and
22 22, so that the closure body 35 may be threaded into the
23 bone screw head, as is shown in Fig. 2.

1 The closure body 35 also includes three bores 44, 45
2 and 46 that are aligned to be parallel with the axis of
3 rotation. The bores 44, 45 and 46 are spaced both from the
4 axis of rotation A and from a periphery 48 of a top 49 of
5 the body. The bores 44, 45 and 46 extend from the body top
6 49 to a bottom surface 50 of the body 35 in the present
7 embodiment. Preferably the bores 44, 45 and 46 are equally
8 spaced from one another and are approximately equally
9 radially spaced outward from the axis of rotation A. In the
10 embodiment illustrated in Figs. 1 through 8, the bores 44,
11 45 and 46 are spaced at approximately 120° from one another.

12 The break-off head 36 includes a neck 54 that joins
13 with the body top 49 at a break-off location 56. Preferably
14 the break-off location 56 is generally coplanar with the
15 body top 49, so the break-off is clean and low profile. The
16 break-off location is normally determined by the location
17 whereat the neck 54 is smallest in cross-section or can be
18 triggered by an external groove. The neck 54 also converges
19 somewhat from the remainder of the break-off head 36 to the
20 break-off location 56.

21 The break-off head 36 includes a number of facets or
22 panels which are aligned to be parallel to the axis of
23 rotation A and which are joined together to form a

1 polyhedral shape typically associated with a structure to be
2 received in a socket-type tool. A combined surface 61 of
3 the facets 60 forms such a polyhedral shape. A top surface
4 63 of the break-off head 36 has axially located therein a
5 non-threaded bore 65 for operably receiving a tool during
6 implantation. The bottom surface 50 of the body 35 includes
7 a conical shaped and axially aligned point 67.

8 A tool 70 is illustrated in Fig. 2 for cooperatively
9 inserting the closure 6 into the bone screw head 13. The
10 tool 70 has an elongate shank 71 with a handle 72 sized and
11 shaped to allow a user to rotate the tool 70 clockwise about
12 the axis of rotation A associated with the closure 6. The
13 tool 70 also has a socket type head 74 opposite the handle
14 72 that is sized and shaped to snugly receive the outer
15 surface 61 of the break off head 36 as is shown in figure 2.

16 During assembly, the rod 7 which is elongate and
17 generally circular in cross-section is placed within the
18 bone screw channel 23 and the closure 6 is then threaded
19 into the bone screw head 13. The tool 70 is used to rotate
20 the closure 6 until it engages the rod 7 and urges the rod 7
21 to seat tightly and snugly on the bone screw head base 20 at
22 the bottom of the channel 23. The point 67 engages and digs
23 into the rod 7. As additional torque is applied to the tool

1 70, a preselected torque is eventually reached (for example
2 90 inch pounds) where the break-off head 36 breaks from the
3 closure body 35 at the break-off location 56 and separates
4 therefrom, such as is shown in Figure 3.

5 Figures 3 and 4 illustrate the closure 6 operably
6 positioned within the bone screw head 13. Figure 5
7 illustrates the closure 6 with the break-off head 36
8 removed, but shown in phantom to illustrate the position of
9 the break-off head 36 relative to the bores 44, 45 and 46.

10 In certain circumstances, it is necessary to remove the
11 closure 6 to readjust the position of the rod 7 or to make
12 some other change in the implant configuration. As
13 mentioned before, the implant 1 is typically a part of an
14 overall system and is normally used to provide support to
15 damaged, injured or missing vertebra of the spinal column.
16 When it is necessary to readjust the system, the closure 6
17 is removed by utilization of the second tool 78. The tool
18 78 includes a shank 80 that has an axis of rotation during
19 use that is coaxial with the axis of rotation A of the
20 closure 6. The shank 80 is attached at one end to a handle
21 81 to provide a grasp and a means of turning the tool 78 by
22 user. Opposite the handle 81, the shank 80 has a flat
23 surface 83 from which three pegs or posts 84, 85 and 86

1 project. The posts 84, 85 and 86 are parallel to the axis
2 of rotation of the tool 78 and are sized, shaped and
3 positioned so as to be snugly receivable in the closure
4 bores 44, 45 and 46, subsequent to removal of the break-off
5 head 36. The tool 78 is shown in position above the closure
6 body 35 in Figure 7 just prior to insertion of the posts 84,
7 85 and 86 into respective bores 44, 45 and 46. The tool 78
8 is shown positioned with the posts 84, 85 and 86 in the
9 respective bores 44, 45 and 46 in Figure 8. The purpose of
10 the tool 70 is to allow user to rotate the closure body 35
11 counter-clockwise and remove the body 35 from the bone screw
12 head 13 after the closure 6 has been seated therein. In
13 this way the channel 23 can be reopened and the rod 7
14 removed or repositioned relative to the bone screw head 13.

15 While the non-axially located bores 44, 45 and 46 of
16 the present embodiment are located between the break-off
17 head neck 54 and the periphery 48, it is foreseen that one
18 or more non-axial bores of this type could partially or
19 entirely intersect with the neck 54 so as to become fully
20 open or exposed at the closure top surface 49 only when a
21 break-off head associated with such a neck breaks from the
22 closure body.

23 Illustrated in Figures 9 to 13 is second embodiment or

1 first modified embodiment of an implant in accordance with
2 the present invention that is generally identified by the
3 reference numeral 101. The implant 101 includes a bone
4 screw 105, a closure 106, a rod 107 and a set screw 108.

5 The bone screw 105 except for the closure is
6 essentially the same as the bone screw 5 and, therefore,
7 will not be described in detail. Reference is made to the
8 description of bone screw 5 for additional detail. The bone
9 screw 105 has a shank 112 and a head 113. Upright arms 121
10 and 122 of the head 113 have inner or interior facing and
11 threaded surfaces 126 and 127.

12 The rod 107 is elongate and has a generally circular
13 cross section for being received in the head 113 beneath the
14 closure 106.

15 The closure 106 is similar in some respects to the
16 closure 6, but is installed in a different manner. In
17 particular, the closure 106 has a generally cylindrical
18 shaped body 135 that has a threaded radially outward surface
19 140 that has a thread thereon that is sized, shaped and
20 positioned to threadedly mate with threads of the arm
21 threaded surfaces 126 and 127, as seen in Figure 10. The
22 thread can be a conventional V-thread, a buttress thread, a
23 reverse angle thread or other threads related to reverse

1 angle threads in that they exert forces to draw or pull the
2 arms 121 and 122 toward one another rather than cause them
3 to splay or open at the top.

4 The body 135 also has a top surface 149 and a bottom
5 surface 150. Positioned to extend downwardly into the body
6 135 from the top surface 149 are four equally spaced bores
7 151, 152, 153 and 154 that do not extend entirely through
8 the body 135 from top to bottom. The bores 151, 152, 153
9 and 154 are spaced from and positioned between both a
10 central axis B and a periphery 158 of the body top surface
11 149. Each bore 151, 152, 153 and 154 is positioned at
12 approximately 90° relative to adjacent bores 151, 152, 153
13 and 154.

14 Located axially and centrally in the body 135 is a
15 threaded bore 161. The threaded bore 161 extends between
16 the top surface 149 and bottom surface 150.

17 The set screw 108 has a threaded shaft 170 sized and
18 shaped to be threadably received in the body threaded bore
19 161. The set screw 170 has sufficient length to extend
20 through and outward from the bottom surface 150. In the
21 second embodiment the set screw 108 has a head 171 that is
22 gripable by a tool for rotation and torquing.

23 A tool 180 is provided for installing and removing the

1 closure 106 form the bone screw head 113. The tool 180 is
2 T-shaped having a shank 181 with a handle 182 attached to
3 one end and a generally flat surface 184 at an opposite end.
4 The surface 184 has four pegs or posts 186 extending
5 therefrom. The posts 186 extend form the surface 184
6 parallel to an axis of rotation of the tool 180 which is the
7 same in use as the axis of rotation B of the closure. The
8 posts 186 are aligned, sized and shaped to mate with the
9 closure body bores 151, 152, 153 and 154.

10 The tool shank 170 also includes an axial bore
11 extending therethrough and receiving a keeper rod 190. The
12 rod 190 has a threaded tip 191 that is adapted to be
13 received in the closure body bore 161 and a grasping head
14 192 at an opposite end.

15 In use the rod 107 is placed in the head 112 and the
16 tool 180 is mated with the closure 106 in the manner shown
17 in Figure 10, so that the four posts 186 are located in
18 respective bores 151, 152, 152 and 154 and the rod tip 191
19 is threaded into the threaded bore 161. The closure 106 is
20 then mated with the head 112 and threaded thereon by mating
21 of the surface 140 with the arm surfaces 126 and 127 until
22 the closure 106 is snug in the bone screw head 113. Torque
23 in a preselected amount is applied to the closure 106 to

1 ensure it is tightly seated in the head 112. In some
2 instances, the closure 106 may just be used to capture the
3 rod 107 and the set screw 108 is used to lock the rod 107 in
4 place. In particular, the tool 180 may be removed and the
5 set screw 108 is then placed in the bore 161 and advanced
6 against the rod 107. A preselected torque is applied to
7 lock the rod 107 in a selected position in the head 112.

8 It is foreseen that the set screw 108 may be of other
9 types than the one illustrated. That is the set screw could
10 have a break-off head in which case the overall implant 101
11 would have a comparatively low profile associated with only
12 the top of the bone screw.

13 For removal, the installation process is reversed.
14 That is the tool 180 is utilized to rotate the closure 106
15 counterclockwise rather than the clockwise direction used
16 for inserting. Where a break off set screw is used, the set
17 screw can be rotated with the body 135 of the closure 106
18 for removal.

19 Illustrated in Figures 14, 15 and 16 is a third
20 embodiment or second modified embodiment of a bone screw
21 closure in accordance with the present invention and
22 generally identified by the reference numeral 206.

23 The closure 206 is in many ways similar to the closure

1 6 and reference is made to the disclosure for the closure 6
2 for additional detail.

3 In particular the closure 206 has a generally
4 cylindrically shaped body 235 that has a radially outer
5 threaded surface 240. The closure 235 also has a break-off
6 head 236 secured to a top or upper surface 249 of the body
7 235 by a neck 254 at a break-off location 256. Positioned
8 between the neck 254 and a periphery 248 of the body upper
9 surface 249 are three bores 244, 245 and 246 that extend
10 parallel to a central axis of rotation identified by a
11 reference numeral C.

12 The major difference between the present embodiment and
13 the closure 6 shown in the first embodiment is that a body
14 235 thereof also includes a central or axial bore 260
15 extending from a bottom surface 250 upward through the body
16 235 to the level of an upper surface 249 of the body 235.
17 The bore 260 is threaded and covered by the neck 254 until
18 the break-off head 236 breaks from the body 235 during
19 installation by application of torque, as was described in
20 the first embodiment. The bore 260 is thereafter exposed
21 upwardly or at the upper surface 249 and adapted to receive
22 a set screw 263 of the type used in the second embodiment or
23 alternatively a break-off type, as shown, set screw having

1 removal slots 264. It is noted that the diameter of the
2 neck 254 at the top surface 249 is larger than the diameter
3 of the bore 260.

4 It is to be understood that while certain forms of the
5 present invention have been illustrated and described
6 herein, it is not to be limited to the specific forms or
7 arrangement of parts described and shown.

8